

In re Patent Application of:

VIGIL ET AL.

Serial No. **09/840,481**

Filing Date: **April 23, 2001**

REMARKS

Applicants would like to thank the Examiner for the thorough examination of the present application, and for correctly recognizing the substantive patentability of the claims over the prior art. The arguments supporting patentability of the claims are provided in detail below.

I. The Claimed Invention

The present invention, as recited in independent method Claim 25, for example, is directed to a method for mitigating multipath in a digital television signal (DTV). The method comprises multiplexing reference data with DTV data to generate a multiplexed DTV data stream, modulating the multiplexed DTV data stream for transmission, and receiving a transmitted DTV signal. Correlation peaks are detected in the received DTV signal based upon the multiplexed reference data, and the detected correlation peaks are used to mitigate multipath in the received DTV signal.

The DTV signal, in its present form, is deficient in its susceptibility to multipath as discussed in the background section of the Applicants' specification. The method in accordance with the present invention advantageously introduces reference data into the DTV data stream to be transmitted. Subsequent processing at the compatible receiver reduces the susceptibility of the DTV signal to multipath. Moreover, the present invention enables effective multipath reception at the compatible receiver while maintaining backwards-compatibility with pre-existing or non-compatible receivers.

Independent method Claim 31 is similar to

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independent method Claim 25 except this claim is directed to the transmitter. In particular, Claim 31 recites estimating modulation characteristics of DTV data to be transmitted, determining reference data based upon the estimated modulation characteristics of the DTV data, multiplexing the reference data with the DTV data to generate a multiplexed DTV data stream, and modulating the multiplexed DTV data stream for transmission.

Independent device Claim 35 is similar to independent method Claim 25, and is directed to digital television (DTV) system comprising a transmitting system and a receiving system. The transmitting system comprises a multiplexer for multiplexing reference data with DTV data to generate a multiplexed DTV data stream, a modulator connected to the multiplexer for modulating the multiplexed DTV data stream, and a transmitter connected to the modulator for transmitting a DTV signal based upon the multiplexed DTV data stream. The receiving system receives the transmitted DTV signal and comprises a correlator for detecting correlation peaks in the received DTV signal based upon the multiplexed reference data, and uses the detected correlation peaks to mitigate multipath in the received DTV signal.

Independent device Claim 42 is directed to a digital television (DTV). The DTV comprises an input and a correlator. The input receives a transmitted DTV signal comprising reference data and DTV data that was multiplexed before being modulated for transmission. The correlator detects correlation peaks in the received DTV signal based upon the multiplexed reference data, and uses the detected correlation peaks to mitigate multipath in the received DTV

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signal.

II. The Claims Are Supported By The Specification

The Examiner rejected Claims 25, 31, 35 and 42 based upon the position that these claims are not supported by the specification.

Independent Claims 25, 35 and 42 recite "detecting correlation peaks in the received DTV signal based upon the multiplexed reference data; and using the detected correlation peaks to mitigate multipath in the received DTV signal."

Support in the specification may be found on page 12, paragraph 43 through page 20, paragraph 60.

Reference is initially directed to page 12, paragraph 43, which describes one embodiment and provides:

"The present invention comprises a method of introducing new, more frequent training symbols into the modulation frame through backward compatible induction. FIG. 11 illustrates the necessary modifications to ATSC DTV transmission and reception systems. In this method, supplemental training sequence data **1110** is introduced into the service multiplexer **125** in the form of periodic packets. Such packets are formed with the ATSC DTV standard in mind and in such a manner as to induce frequent and advantageous training symbol components **1120** into the ATSC DTV modulation frame (as illustrated in FIG. 2). (Emphasis added).

After inducing the training symbol components into the DTV modulation frame, the multiplexed DTV data may be transmitted. The transmitted signal may be received by the

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correlator and equalizer as illustrated in FIG. 11. Reference is also directed to page 14, paragraph 43, which describes an embodiment and provides:

"The essence of this method is the exploitation of the mapping to induce frequent regular periodic training symbol components into the modulation frame so as to enable effective multipath reception at the compatible receiver while maintaining backwards-compatibility with pre-existing legacy reception equipment. It is important that the training symbol components induced into the ATSC DTV modulation frame be of sufficient number and frequency as to enable effective multipath reception. Such a frequency and number are determined by evaluating relevant propagation parameters."
(Emphasis added).

The Applicants respectfully submit that one skilled in the art readily understands that correlation is to be performed to detect the training symbol components (which are of sufficient number and frequency) to enable effective multipath reception by the receiver. Paragraph 17, lines 3-4 provides "[p]eriodicity is essential so that the receiver is able to find the induced referenced symbols." (Emphasis added).

Paragraphs 53 and 54 discuss in greater detail how this periodicity may be introduced by the transmitter. Paragraph 55 discloses an embodiment and further provides:

"As such, the preferred embodiment offers adequate and sufficiently frequent means to characterize multipath suitably for reliable ATSC DTV receiver channel

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characterization and demodulation, or to otherwise serve as a reference against which to train the corresponding equalizers." (Emphasis added).

In other words, the specification clearly discloses that the receiver performs certain steps to take advantage of the reference data that is multiplexed along with the DTV data. The processing performed by the receiver is based upon the detailed discussion in the Applicants' specification concerning the training symbols. The training symbols are defined by the reference data. Detection of the correlation peaks is clearly supported by paragraphs 59-61, which describes an embodiment and provides:

"An alternative reception method involves the following:

1. Use of a correlator to determine a sufficiently accurate approximation $\hat{h}(n,m)$ for the multipath channel response $\bar{h}(n,m)$ 540 at every training waveform interval; and
2. Use of an LMS, RLS or other relevant technique to approximate the necessary inverse-channel function $\bar{h}^{-1}(n,m)$ 610 required in the implementation of the required equalizer $\hat{h}^{-1}(n,m)$ 610.

In terms of the correlator, an objection may be raised in terms of anticipated complexity. However, a very computationally efficient correlator is constructed as follows:

1. ATSC DTV 8-VSB symbol states (-7, -5, -3, -1, 1, 3, 5 and 7) are offset in accordance with the ATSC DTV standard by a pilot of magnitude 1.25, but the effective symbol states become (-5.75, -3.75, -1.75, 0.25, 2.25, 4.25, 6.25 and 8.25);
2. A reasonable and acceptable approximation to these states are the states (-6, -

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4, -2, 0, 2, 4, 6 and 8);

3. Correlation of a $96 \times 2 = 192$ symbol sequence involves 192 multiplies per point, which is extremely computationally intensive. However, the required multiplies, subject to the approximation above, may instead be implemented in fixed-point arithmetic using successive bit-shifts and adds (i.e., multiplication by 4 is a 2-bit shift; multiplication by 6 is the sum of the results of a 1-bit shift and a 2-bit shift). The resulting implementation significantly reduces computations; and

4. A minor modification of the ATSC DTV standard includes a change in the pilot level from 1.25 to 1 renders the above approximation (step 2) exact.

The preferred reception method involves the use of the correlator as described above to acquire and maintain symbol and frame timing while using the reference-trained equalization process of FIG. 8 to suppress multipath-induced intersymbol interference." (Emphasis added).

The Applicants respectfully submit that independent Claims 25, 35 and 42 are supported by the originally filed specification as discussed above. Referring now to dependent Claim 31, this claim recites "estimating modulation characteristics of DTV data to be transmitted; determining reference data based upon the estimated modulation characteristics of the DTV data". The Examiner has also taken the position that this portion of the claim is not supported by the specification. Support in the specification may be found on page 14, paragraph 49 through page 16, paragraph 51.

In paragraph 49, lines 10-12, the frequency and number of training symbol components "are determined by evaluating relevant propagation parameters." (Emphases added). Paragraphs 50 and 51 discuss in greater detail the relevant

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propagation parameters, such as the highest transmission frequency and the multipath delay spread. The Applicants respectfully submit that dependent Claim 31 is also supported by the specification.


Therefore, the Applicants submit that all of the claims are supported by the specification. Consequently, the final rejection should be withdrawn.

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CONCLUSION

In view of the remarks provided herein it is submitted that all the claims are patentable. Accordingly, a Notice of Allowance is requested in due course. Should any minor informalities need to be addressed, the Examiner is encouraged to contact the undersigned attorney at the telephone number listed below.

Respectfully submitted,



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